

Claims

- 508
A, >
1. A sol-gel coating material comprising
- 5 (A) an acrylate copolymer solution comprising at least one acrylate copolymer (A1) preparable by copolymerizing at least the following monomers:
- 10 a1) at least one (meth)acrylic ester which is substantially free of acid groups,
- a2) at least one ethylenically unsaturated monomer which carries at least one
- 15 hydroxyl group per molecule and is substantially free of acid groups, and
- a3) at least one ethylenically unsaturated monomer which carries per molecule at
- 20 least one acid group which can be converted into the corresponding acid anion group;
- (B) a stock varnish preparable by hydrolyzing and
- 25 condensing at least one hydrolyzable silane (B1) of the general formula I



in which the variable R has the following definition:

R = hydrolyzable groups, hydroxy groups and nonhydrolyzable groups, with the proviso that at least one, preferably at least two, hydrolyzable group(s) is or are present;

and

(C) an additive solution comprising

c1) at least one ethylenically unsaturated compound containing at least one epoxide group,

c2) at least one silane (B1) having at least one nonhydrolyzable group R which contains at least one epoxide group, and

c3) at least one adduct of at least one silane (B1) having at least one nonhydrolyzable group R which contains at least one amino group and at least one cyclic ethylenically unsaturated dicarboxylic anhydride.

2. The sol-gel coating material of claim 1, characterized in that it comprises, based in each case on its overall amount, from 5 to 20, preferably from 10 to 15 and in particular from 11 to 14% by weight of the acrylate copolymer solution (A), from 40 to 85, preferably from 45 to 80, and in particular from 50 to 75% by weight of the stock varnish (B), and from 0.5 to 3, preferably from 1 to 2, and in particular from 1.2 to 1.7% by weight of the additive solution (C).
3. The sol-gel coating material of claim 1 or 2, characterized in that the solids contents of the constituents (A), (B) and (C) are in a weight ratio of (A) : (B) : (C) of
- 1 to 10 : 30 to 60 : 1
 - preferably 2 to 8 : 35 to 55 : 1, and
 - in particular 2.5 to 6 : 40 to 50 : 1.
4. The sol-gel coating material of one of claims 1 to 3, characterized in that the stock varnish (B) comprises at least one hydrolyzable metal compound of the general formula II



in which the variables and the index have the following definition:

M = aluminum, titanium or zirconium,

R = hydrolyzable groups, hydroxy groups, and non-hydrolyzable groups, with the proviso that at least one, preferably at least two, hydrolyzable group(s) is or are present, and

n = 3 or 4.

5. The sol-gel coating material of one of claims 1 to 4, characterized in that

- the nonhydrolyzable groups R are alkyl groups, especially having from 1 to 4 carbon atoms; alkenyl groups, especially having from 2 to 4 carbon atoms; alkynyl groups, especially having from 2 to 4 carbon atoms; and/or aryl groups, especially having from 6 to 10 carbon atoms; and

- the hydrolyzable groups R are hydrogen atoms, alkoxy groups, especially having from 1 to 20 carbon atoms; alkoxy-substituted alkoxy groups having from 3 to 20 carbon atoms; acyloxy groups, especially having from 1 to 4

0914937 10801

carbon atoms; alkylcarbonyl groups, especially having from 2 to 6 carbon atoms.

6. The sol-gel coating material of claim 5, characterized in that

10 - the hydrolyzable groups R are methoxy, ethoxy, n-propoxy, i-propoxy, n-butoxy, sec-butoxy, beta-methoxyethoxy, acetoxy, propionyloxy and/or acetyl groups and the

15 - the nonhydrolyzable groups R are methyl, ethyl, propyl, butyl vinyl, 1-propenyl, 2-propenyl, butenyl, acetylenyl, propargyl, phenyl and/or and naphthyl groups.

7. The sol-gel coating material of one of claims 1 to 6, characterized in that the nonhydrolyzable groups R contain at least one functional group, in particular at least one epoxide group, amino group, olefinically unsaturated group, mercapto group, and/or isocyanate group and/or reaction products thereof with further reactive compounds.

25 8. The sol-gel coating material of one of claims 1 to 7, characterized in that it is a sol-gel clearcoat material.

00014037.10001

9. The use of the sol-gel coating material in accordance with one of claims 1 to 8 to produce scratch-resistant sol-gel coatings, especially for single-coat or multicoat paint systems.

5

10. The use of the sol-gel coating material of claim 9, characterized in that the paint systems in question are fully cured single-coat or multi-coat paint systems.

10

11. The use of the sol-gel coating material of claim 9 or 10, characterized in that the paint systems are automotive OEM paint systems, automotive refinish paint systems, industrial paint systems, including container coatings, coatings on plastics and furniture coatings.

15

12. A process for producing scratch-resistant sol-gel coatings by applying and curing sol-gel coating materials on primed or unprimed substrates or unprimed or primed substrates provided with a single-coat or multicoat paint system, characterized in that a sol-gel coating material in accordance with one of claims 1 to 8 is used in this process.

20

25

13. A process for producing scratch-resistant sol-gel coatings by applying and curing sol-gel coating materials on unprimed or primed substrates which

00544937-110001

have been provided with a single-coat or multicoat paint system, characterized in that, prior to the application of the sol-gel coating material,

5 (i1) a single-coat paint system based on a one-component (1K) clearcoat material, two-component (2K) or multicomponent (3K, 4K) clearcoat material, powder clearcoat material or UV-curable clearcoat material,

10

(i2) a multicoat color and/or effect paint system with a topmost coat based on a one-component (1K) clearcoat material, two-component (2K) or multicomponent (3K, 4K) clearcoat material, powder clearcoat material or UV-curable clearcoat material, especially a one-component (1K) clearcoat material, two-component (2K) or multicomponent (3K, 4K) clearcoat material, or

15

20

(i3) a single-coat color and/or effect paint system based on a two-component (2K) solid-color topcoat material

25

is applied and partly cured.

14. The process of claim 13, characterized in that a sol-gel coating material in accordance with one of claims 1 to 8 is used in this process.

00044937 110004

A

15. The process of one of claims 12 to 14, characterized in that the applied sol-gel coating material is cured by exposure to middle-range IR radiation.

5

16. The process of one of claims 12 to 15, characterized in that the paint systems are automotive OEM paint systems, automotive refinish paint systems, industrial paint systems, including container coatings, and furniture coatings.

10

17. Sol-gel coatings which can be produced from a sol-gel coating material in accordance with one of claims 1 to 8 and/or by the process in accordance with one of claims 12 to 16.

15

18. Substrates comprising at least one sol-gel coating in accordance with claim 17.

END A.

Figure 1. The effect of the concentration of the *Agrobacterium* suspension on the transformation efficiency of *Agrobacterium* strains. The *Agrobacterium* strains were incubated in the presence of 100 mg/ml of gentamicin and 100 mg/ml of rifampicin. The concentration of the *Agrobacterium* suspension was 10⁶ cells/ml. The transformation efficiency was determined by the number of transformants per 10⁶ cells of *Agrobacterium* strain. The data are the mean \pm SD of three independent experiments.